5-YEAR REVIEW

Short Form Summary

Species Reviewed: *Pritchardia napaliensis* (loulu palm)

Current Classification: Endangered

Federal Register Notice announcing initiation of this review:

[USFWS] U.S. Fish and Wildlife Service. 2008. Endangered and threatened wildlife and plants; initiation of 5-year status reviews of 70 species in Idaho, Montana, Oregon, Washington, and the Pacific Islands. Federal Register 73(83):23264-23266.

Lead Region/Field Office:

Region 1/Pacific Islands Fish and Wildlife Office, Honolulu, Hawaii

Name of Reviewer(s):

Marie Bruegmann, Pacific Islands Fish and Wildlife Office, Plant Recovery Coordinator
Marilet A. Zablan, Pacific Islands Fish and Wildlife Office, Assistant Field Supervisor for Endangered Species
Jeff Newman, Pacific Islands Fish and Wildlife Office, Acting Deputy Field Supervisor

Methodology used to complete this 5-year review:

This review was conducted by staff of the Pacific Islands Fish and Wildlife Office of the U.S. Fish and Wildlife Service (USFWS), beginning on April 29, 2008. The review was based on the final critical habitat designation for *Pritchardia napaliensis* and other species from the island of Kauai (USFWS 2003), as well as a review of current, available information. The National Tropical Botanical Garden provided an initial draft of portions of the 5-year review and recommendations for conservation actions needed prior to the next five-year review. The evaluation of Tamara Sherrill, a biological consultant, was reviewed by the Plant Recovery Coordinator. The document was then reviewed by the Assistant Field Supervisor for Endangered Species and Acting Deputy Field Supervisor before submission to the Field Supervisor for approval.

Background:

For information regarding the species listing history and other facts, please refer to the Fish and Wildlife Service's Environmental Conservation On-line System (ECOS) database for threatened and endangered species (http://ecos.fws.gov/tess_public).

Application of the 1996 Distinct Population Segment (DPS) Policy:

This Policy does not apply to plants.

Review Analysis:

Please refer to the final critical habitat designation for *Pritchardia napaliensis* published in the Federal Register on February 27, 2003 (USFWS 2003) for a complete review of the species' status (including biology and habitat), threats, and management efforts. No new threats and no significant new information regarding the species biological status have

come to light since listing to warrant a change in the Federal listing status of *P. napaliensis*.

In 1996, when the species was listed and in 1998, when the recovery plan for the species was written, USFWS knew of three populations of *Pritchardia napaliensis* totaling no more than 90 individuals (USFWS 1996, 1998). When critical habitat was designated in 2003, after more extensive surveys, *P. napaliensis* was known from five populations totaling 155 individuals on State-owned land in Pohakuao, Alealau, Waiahuakua, and Hoolulu Valley, all within the Hono o Na Pali Natural Area Reserve and Na Pali Coast State Park (USFWS 2003). It has not been noted again at Waiahuakua or Alealau, but has been documented in Hanakapiai Valley (Wood 2009). Additionally, three individuals in lower Limahuli Valley, which were previously considered *P. limahuliensis* have been possibly reclassified as *P. napaliensis* (Hodel 2007). *Pritchardia napaliensis* is currently known to have only 157 individuals occurring in three isolated valleys along the Na Pali Coast. One population can be found in Hoolulu Valley with 55 individuals, another is found in Pohakuao with 86 individuals, and the third population is in Hanakapiai with 16 individuals (Wood 2009).

In Hoolulu Valley, on the Na Pali coast at 106 meters (350 feet) elevation, 25 to 40 individuals were noted in 1998 (National Tropical Botanical Garden 2008a). In 2005, 15 mature and five immature individuals were seen at 107 meters (351 feet) elevation (Tangalin 2009). In 2006, about 30 individuals were seen at 201 meters (659 feet) elevation (Wood 2009). In 2006, another observer also noted 20 individuals at 183 meters (600 feet) elevation (Perlman 2009). Approximately 55 individuals are found in Hoolulu Valley (Wood 2009).

In Waiahuakua Valley one individual was seen west of the falls at 457 meters (1,500 feet) elevation in 1993 (Perlman 2008). In 1999, one individual tree, an outlier from the Hoolulu group, was observed on a ridge between Hoolulu and Waiahuakua, at 207 meters (680 feet) elevation (National Tropical Botanical Garden 2008a). In Hanakapiai Valley, up to 16 individuals were reported between 1996 and 1999 on the west side of the valley on steep slopes below Pohakea at 290 meters (950 feet) elevation (Perlman 2009). Ken Wood of the National Tropical Botanical Garden currently estimates there are 16 individuals in the Waiahuakua Valley (Wood 2009).

In the isolated upper Pohakuao Valley above the falls, north of Kalalau and south of Hanakoa, 50 mature individuals of *Pritchardia napaliensis* were seen at 427 to 732 meters (1,401 to 2,402 feet) elevation in 2002 (National Tropical Botanical Garden 2008a). Another estimate in 2002 was up to 100 individuals at 518 meters (1,699 feet) (National Tropical Botanical Garden 2008a). There may also still be at least one outlier at a slightly lower elevation in the eastern drainages of the valley, on the lower walls of Manono Ridge, at 396 to 442 meters (1,299 to 1,450 feet) elevation (National Tropical Botanical Garden 2008a). Currently there are believed to be 83 individuals at Pohakuao (Wood 2009).

In Alealau, on the northeast rim above Kalalau Valley, two individuals were observed at 1,158 meters (3,800 feet) elevation in 1992, but have not been inventoried since (Hawaii Biodiversity and Mapping Program 2009). In lower Limahuli three individual palms, previously identified as *Pritchardia limahuliensis*, are now considered by Hodel (2007) to potentially be *P. napaliensis*. They are distinct in appearance from the upper Limahuli *Pritchardia* individuals. They grow between 269 and 333 meters (883 to 1,092 feet) elevation (Tangalin 2009), and were last observed in April 2008 (National Tropical Botanical Garden 2008a).

Genetic analysis is currently being done on *Pritchardia* species to further delineate species relationships (Christine D. Bacon, Colorado State University, pers. comm. 2009).

Studies on seed dormancy and germination in another *Pritchardia* species, such as *Pritchardia remota*, may give some clues to the physiology of *P. napaliensis* as well (Perez *et al.* 2008). Mature, intact drupes of *P. remota* are dormant at shedding. As physiological dormancy is broken, the embryo grows to eventually dislodge the seed coat, and continues to develop and produce a radicle in five to 21 weeks. Survival of seeds until they can germinate depends on seeds being buried in soil at warm constant temperatures of 25 to 35 degrees Celsius. This was more effective than alternating temperatures in promoting germination (Perez *et al.* 2008).

An unusual crown growth of the endangered *Pritchardia napaliensis* was described and documented from *ex situ* (at other than the plant's natural location, such as a nursery or arboretum) collections at the National Tropical Botanical Garden on Kauai. Greenhouse experiments were conducted to determine the cause of a form of leaf suckering from the growing tip which had been observed on *P. napaliensis* in the garden. The growing meristem was mechanically and chemically treated to attempt to replicate this anomaly, but it remained unclear what caused the unusual crown growth (Chapin 2003).

Pritchardia napaliensis typically grows at a wide variation of elevations between 152 and 1,158 meters (500 and 3,800 feet) in a wide variety of habitats (USFWS 1998, 2003). Pohakuao, an upper isolated hanging valley northeast of Kalalau and southwest of Hanakoa, has relictual *Diospyros sandwicensis* (lama) – *Metrosideros polymorpha* (ohia) mesic forest and diverse mesic forest with a secondary succession of invasive introduced plant species. Associated native species include *Antidesma platyphylla* (hame), *Bidens sandvicensis* subsp. *sandvicensis* (kookoolau), *Canavalia napaliensis* (awikiwiki), *Carex wahuensis* (no common name [NCN]), *C. meyenii* (NCN), *Diospyros hillebrandii*, *D. sandwicensis*, *Metrosideros polymorpha* var. *glaberrima* (ohia), *Microlepia strigosa* (palapalai), *Pleomele aurea* (hala pepe), *Pouteria sandwicensis* (alaa), *Psychotria mariniana* (kopiko), *Rauvolfia sandwicensis* (hao), *Santalum freycinetianum* var. *pyrularium* (iliahi), *Streblus pendulinus* (aiai), and *Tetraplasandra waimeae* (ohe kiko ola) (National Tropical Botanical Garden 2008a, b).

On Hanakapiai Valley's steep slopes below Pohakea, the habitat is *Diospyros sandwicensis – Metrosideros polymorpha* mesic forest with *Alyxia stellata* (maile), *Euphorbia haeleeleana* (NCN), *Hibiscus kokio* ssp. *saintjohnianus* (kokio ula), *Ochrosia*

kauaiensis (holei), *Pisonia* sp. (kalau), *Pleomele aurea*, *Pittosporum sp.* (hoawa), *Psydrax odorata* (alahee), *Pteralyxia kauaiensis* (kaulu), *Rauvolfia sandwicensis*, *Santalum* sp., *Syzygium sandwicensis* (ohia ha), and *Xylosma* sp. (maua) (Perlman 2009)

In Hoolulu Valley where *Pritchardia napaliensis* grows below a small waterfall, the habitat is *Diospyros sandwicensis – Pandanus tectorius* (hala) lowland mesic forest with associated species including *Aleurites moluccana* (kukui), *Alyxia stellata*, *Bidens* sp. (kookoolau), *Bobea* sp. (ahakea), *Carex meyenii*, *Charpentiera densiflora* (papala), *Cyanea coriacea* (haha), *Diospyros sandwicensis*, *D. hillebrandii*, *Freycinetia arborea* (ie ie), *Ochrosia* sp., *Peucedanum sandwicense* (makou), *Pisonia umbellifera* (papala kepau), *Pittosporum napaliense* (hoawa), *Psychotria mariniana*, *Rauvolfia sandwicensis*, and *Wikstroemia oahuensis* (akia) (National Tropical Botanical Garden 2008a; Perlman 2009; Tangalin 2009; Wood 2009)

In Waiahuakua, the habitat is *Metrosideros polymorpha – Pandanus tectorius* mesic forest with *Charpentiera densiflora*, *Diospyros sandwicensis*, *Munroidendron racemosum* (NCN), *Nestegis sandwicensis* (olopua), *Ochrosia kauaiensis*, *Pisonia* sp., *Pittosporum napaliensis*, *Pleomele aurea*, *Psydrax odorata*, *Rauvolfia sandwicensis*, and *Wikstroemia oahuensis* (Perlman 2009).

Alealau, above Kalalau Valley, has *Metrosideros polymorpha – Dicranopteris linearis* montane wet forest with the associated species *Cheirodendron trigynum* (olapa), *Dubautia knudsenii* (naenae), *Melicope peduncularis* (alani), *Phyllostegia electra* (NCN), *Poa sandvicensis* (NCN), *Schiedea lychnoides* (kuawawaenohu), *Stenogyne purpurea* (NCN), and *Vaccinium dentatum* (ohelo) (Hawaii Biodiversity and Mapping Program 2009).

Lower Limahuli's natural community is mixed wet lowland forest with associated species including *Alyxia stellata*, *Bidens forbesii* (kookoolau), *Bobea elatior* (ahakea lau nui), *Chamaesyce* sp. (akoko), *Cyanea coriacea*, *C. hardyi* (haha), *Diospyros sandwicensis*, *Doodia lyonii* (NCN), *Freycinetia arborea*, *Hibiscus kokio* ssp. *saintjohnianus*, *Kadua acuminata* (au), *Ochrosia* sp., *Pipturus kauaiensis* (mamake), *Pleomele aurea*, *Psychotria mariniana*, *Psydrax odorata*, *Schiedea kauaiensis* (NCN), *Thelypteris globulifera* (NCN), and *Wikstroemia oahuensis* (Tangalin 2009). In Hanakapiai, the habitat is *Metrosideros polymorpha – Diospyros sandwicensis* mesic forest with *Euphorbia haeleeleana*, *Hibiscus kokio* ssp. *saintjohnianus*, *Pisonia* sp., *Pleomele aurea*, *Psydrax odorata*, *Pteralyxia kauaiensis*, *Rauvolfia sandwicensis*, and *Syzygium sandwicense* (Perlman 2009).

Major threats to *Pritchardia napaliensis* include habitat degradation and grazing by feral goats (*Capra hircus*) and pigs (*Sus scrofa*) (Factor A and C); seed predation by rats (*Rattus rattus*) (Factor C); and competition with invasive introduced plant species (Factor E) (USFWS 1998, 2003).

In Hoolulu, threats are competition with invasive introduced plant species (Factor E) including *Aleurites moluccana* (kukui), *Bryophyllum pinnatum* (airplant), *Christella*

dentata (downy wood fern), *Clidemia hirta* (Koster's curse), *Cordyline fruticosa* (ti), *Elephantopus mollis* (elephant's foot, tobacco weed), *Oplismenus hirtellus* (basketgrass), *Pluchea carolinensis* (sourbush), *Psidium guajava* (common guava), *Lantana camara* (lantana), *Melinis minutiflora* (molasses grass), *Rubus rosifolius* (thimbleberry), and *Schefflera actinophylla* (octopus tree) (Tangalin 2009; Wood 2009). In Pohakuao, invasive introduced plant species (Factor E) are *Bryophyllum pinnatum*, *Erigeron karvinskianus* (daisy fleabane), *Lantana camara*, and *Pluchea carolinensis* (National Tropical Botanical Garden 2008a). Lower Limahuli's invasive introduced plant species (Factor E) include *Andropogon virginicus* (broomsedge), *Blechnum appendiculatum* (NCN), *Bryophyllum pinnatum*, *Clidemia hirta*, *Clusia rosea* (autograph tree), *Erigeron karvinskianus*, *Lantana camara*, *Nephrolepis falcata* (fishtail fern), *Pluchea* sp., *Psidium guajava*, and *Rubus rosifolius* (Tangalin 2009). Hanakapiai's invasive introduced plant species (Factor E) are *Aleurites moluccana*, *Bryophyllum pinnatum*, *Lantana camara*, *Psidium guajava*, and *Setaria parviflora* (yellow foxtail) (National Tropical Botanical Garden 2008b).

Theft of plants and seeds by avid palm collectors is a threat (Factor B). The species is also threatened by vandalism (Factor E). In 1993, the fence surrounding 39 recently planted *Pritchardia napaliensis* on Kauai was vandalized and those plants were stolen (USFWS 2003).

Goats graze (Factor C) and pigs uproot seedlings (Factor A) in Hoolulu, and rats chew seeds (Factor C) in Limahuli (Tangalin 2009). The remote location of some of these individuals makes rat bait maintenance problematic.

Climate change may also pose a threat to *Pritchardia napaliensis* (Factors A and E). However, current climate change models do not allow us to predict specifically what those effects, and their extent, would be for this species.

As of 1997, one population of *Pritchardia napaliensis* in the Hono o Na Pali Natural Area Reserve (in Hoolulu valley) was fenced to exclude pigs and goats by the Kauai Division of Forestry and Wildlife (USFWS 1998).

Seeds have been collected and propagated for outplanting. Since 1989, 73 individual trees of *Pritchardia napaliensis* survive from the approximately 250 planted for genetic storage in National Tropical Botanical Gardens on Kauai. In 2007, their nursery had 54 plants and had received 1,060 seeds. As of 2009, their nursery had 129 seeds in storage (National Tropical Botanical Garden 2009). Thirty-seven individuals were planted at the National Tropical Botanical Garden's McBryde Garden in 2004 to 2005 (National Tropical Botanical Garden 2008c). Twenty four additional individuals were planted in 2006 to 2007 at the botanical garden, and 12 individuals were planted during this time at Makauwahi Cave (National Tropical Botanical Garden 2007, 2008c, 2008d). Also on Kauai, the Division of Forestry and Wildlife has 48 seeds collected from the Kepapa exclosure (Division of Forestry and Wildlife 2008). On Oahu, Waimea Valley Arboretum has five plants in its collection which were propagated from two wild trees (Waimea Valley Arboretum 2009). Also on Oahu, Lyon Arboretum has four tissue

cultured plants created from four seeds, three from the Napali coast and one from Hoolulu valley (Harold L. Lyon Arboretum 2008). In addition, five seeds are in long-term storage at Lyon Arboretum (Center for Conservation Research and Training Seed Storage Facility 2008).

Stabilizing, downlisting, and delisting objectives are provided in the addendum to the recovery plan for the Kauai plant cluster (USFWS 1998), based on whether the species is an annual, a short-lived perennial (fewer than 10 years), or a long-lived perennial. *Pritchardia napaliensis* is a long-lived perennial, and to be considered stable, the taxon must be managed to control threats (*e.g.*, fenced) and be represented in an *ex situ* collection. In addition, a minimum of three populations should be documented on the island of Kauai. Each of these populations must be naturally reproducing and increasing in number, with a minimum of 25 mature individuals per population.

The interim stabilization goals for this species have not been met (see Table 1), as only two populations have more than 25 mature individuals and all threats are not being managed. Therefore, *Pritchardia napaliensis* meets the definition of endangered as it remains in danger of extinction throughout its range.

Recommendations for Future Actions:

- Control ungulates and invasive introduced plants in the existing wild populations.
- Continue to collect material for genetic storage and propagation for reintroduction.
- Augment wild populations.
- Assess potential sites for establishing reintroductions.
- Determine suitable methods and implement rat control.
- Work with Hawaii Division of Forestry and Wildlife to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species.

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Personal Communications

Bacon, Christine D. McBryde Graduate Fellow of the National Tropical Botanical Garden, Program in Molecular Plant Biology Fellow, Doctoral Candidate, Department of Biology, Colorado State University Fort Collins, Colorado. E-mail to Margaret Clark, National Tropical Botanical Garden, dated January 15, 2009. Subject: *Pritchardia napaliensis* research.

Table 1. Status of *Pritchardia napaliensis* from listing through 5-year review.

Date	No. wild indivs.	No. outplanted	Stability Criteria identified in Recovery Plan	Stability Criteria Completed?
1996 (listing)	< 90	0	All threats managed in all 3 populations	No
			Complete genetic storage	No
			3 populations with 25 mature individuals each	No
1998 (recovery plan)	< 90	0	All threats managed in all 3 populations	Partially
			Complete genetic storage	Partially
			3 populations with 25 mature individuals each	No
2003 (critical habitat)	155	0	All threats managed in all 3 populations	Partially
			Complete genetic storage	Partially
			3 populations with 25 mature individuals each	No
2009 (5-year review)	157	0	All threats managed in all 3 populations	Partially
			Complete genetic storage	Partially
			3 populations with 25 mature individuals each	No

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SIGNATURE PAGE for 5-YEAR REVIEW of *Pritchardia napaliensis*

Pre-1996 DPS listing still considered a listable entity? N/A

Recommendation resulting from the 5-year review:

_____ Delisting
_____ Reclassify from Endangered to Threatened status
_____ Reclassify from Threatened to Endangered status
_X_ No Change in listing status

Field Supervisor, Pacific Islands Fish and Wildlife Office

Date AUG 2 7 2010